## REMARKS/ARGUMENTS

The Office Action mailed August 31, 2004, has been received and reviewed. Claims 1 through 29 are currently pending in the application. Claims 27 through 29 are withdrawn from consideration as being directed to a nonelected invention and have been canceled herein. Claims 1 through 26 stand rejected. Applicants have amended claims 1, 3, and 19, canceled claim 11, added new claim 30, and respectfully request reconsideration of the application as amended herein.

Independent claims 1 and 19 have been amended to recite that the at least one surfactant comprises α-(nonylphenyl)-omega-hydroxy-branched poly (oxy-1,2-ethanediyl) and 2,4,7,9-tetramethyl-5-decyne-4,7-diol-ethoxylate. Support for this amendment is found in the as-filed specification at at least paragraph [0022].

New claim 30 substantially recites the subject matter of as-filed claim 1, except that the transitional phrase "comprising" in the second limitation has been replaced with the transitional phrase "consisting essentially of."

**Defective Oath/Declaration**

A Corrected Declaration is filed with this Amendment to specify the citizenship of the second joint inventor.

**35 U.S.C. § 103(a) Obviousness Rejections**

Obviousness Rejection Based on U.S. Patent No. 6,057,248 to Wu et al. and Further in View of U.S. Patent No. 6,465,403 to Skee

Claims 1 through 26 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,057,248 to Wu et al. ("Wu et al.") in view of U.S. Patent No. 6,465,403 to Skee ("Skee"). Claim 11 has been canceled, rendering moot the rejection as to this claim. Applicants respectfully traverse this rejection as to the remaining claims, as hereinafter set forth.

M.P.E.P. 706.02(j) sets forth the standard for an obviousness rejection:

> To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or combine reference teachings. Second, there must

> be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

The obviousness rejection of claims 1 through 10 and 12 through 26 is improper because Wu et al. and Skee do not teach or suggest all of the claim limitations. Furthermore, the cited references do not provide a motivation to combine their teachings to produce the claimed invention.

Wu et al. teaches a method of removing residual particles present after CMP from the grooves of an alignment mark on a semiconductor wafer using a solution of ammonium hydroxide, hydrogen peroxide, and water in a dip process wherein the wafer is subjected to 10 to 2000 watts of sonic power. (Wu et al., at column 1, lines 59-62, and column 2, lines 38-53.) As acknowledged by the Examiner, Wu et al. does not teach the sizes of the trenches or grooves this method will clean or the types of particles capable of being removed by this method. (See, generally, *Id.* and Office Action of August 31, 2004, hereinafter referred to as "Office Action," at page 5.) As acknowledged by the Examiner, Wu et al. also does not teach use of a surfactant or "the manner in which the cleaning solution is applied." (See, Office Action at pages 3-5.) Additionally, Wu et al. does not teach the frequency (usually measured in Hertz) at which the megasonic or ultrasonic pulse is administered to the wafer. Wu et al. only teaches the intensity of power to be used to generate the ultrasonic or megasonic vibrations, which are measured in watts. (See, Wu et al. at column 1, lines 59-62, and column 2, lines 38-53.) Wu et al. also does not teach a pH range or a temperature range at which the cleaning solution is to be used. (See generally, *Id.*)

Skee teaches a semiconductor wafer cleaning solution that minimizes corrosion caused by alkaline stripping of films containing aluminum or other active alloys. (Skee at column 2, lines 43-55, and column 10, lines 30-33.) The solution is designed to be used after a semiconductor is photoresist coated, etched, and ashed using $O_2$ plasma. (*Id.* at column 3, lines 1-5 and column 4, lines 10-13 and column 4, lines 62-65.) The cleaning solution taught by Skee contains a chelator, such as EDTA, a silicate, such as $SiO_2$, 0.1% to 2.0% of tetramethylammonium hydroxide

("TMAH"), and 0.1 to 0.3 weight % of a surfactant. (*Id.* at column 3, lines 55-59, column 6, lines 25-27, column 9, lines 26-27, and column 8, line 67.) Skee teaches a water-soluble organic solvent cleaner of pH between 8 and 11, and pH higher than 11, that may be used at temperatures from 10°C to 85°C. (*Id.* at column 4, lines 43-53, column 5, lines 35-40, and column 10, lines 66-67.) As acknowledged by the Examiner, Skee teaches using this solution either in a bath or as a spray, but does not teach using this solution in a "high-pressure jet spray or a high-velocity aerosol spray." (*Id.* at column 10, lines 62-63, Specification at paragraph [0026], and Office Action at page 7.) Skee further does not teach cleaning solutions containing more than 2.0% TMAH solutions containing Surfynol® CT-131, or solutions without silicate present. (Skee at column 6, lines 35-37.) Skee does not disclose exposure of the semiconductor wafer to a megasonic or ultrasonic vibrational energy.

As amended, each of claims 1 and 19 recites a method of cleaning a semiconductor wafer including at least one registration mark. The method comprises, *inter alia*, exposing or contacting the semiconductor wafer to a cleaning solution that comprises TMAH and at least one surfactant. The at least one surfactant comprises α-(nonylphenyl)-omega-hydroxy-branched poly (oxy-1,2-ethanediyl) and 2,4,7,9-tetramethyl-5-decyne-4,7-diol-ethoxylate.

The cited references do not teach or suggest the limitations of "exposing the semiconductor wafer to a cleaning solution comprising tetramethylammonium hydroxide and at least one surfactant, the at least one surfactant comprising α-(nonylphenyl)-omega-hydroxy-branched poly (oxy-1,2-ethanediyl) and 2,4,7,9-tetramethyl-5-decyne-4,7-diol-ethoxylateα-(nonylphenyl)-omega-hydroxy-branched poly (oxy-1,2-ethanediyl) and 2,4,7,9-tetramethyl-5-decyne-4,7-diol-ethoxylate" or "contacting the semiconductor wafer with a spray of a cleaning solution comprising tetramethylammonium hydroxide and at least one surfactant, the at least one surfactant comprising α-(nonylphenyl)-omega-hydroxy-branched poly (oxy-1,2-ethanediyl) and 2,4,7,9-tetramethyl-5-decyne-4,7-diol-ethoxylate" as recited in independent claims 1 and 19, respectively. As stated above, Wu et al. does not teach or suggest using surfactants and, therefore, necessarily does not teach or suggest using the recited surfactants. While Skee teaches using several types of surfactants, Skee does not teach or suggest using the recited compounds or

using these compounds as components of the cleaning solution. Thus, the cited references do not teach or suggest all of the limitations of independent claims 1 or 19.

The cited references also do not provide a motivation to combine to produce the claimed invention. To provide a motivation or suggestion to combine, the prior art or the knowledge of a person of ordinary skill in the art must "suggest the desirability of the combination" or provide "an objective reason to combine the teachings of the references." M.P.E.P. § 2143.01. The Examiner states that "it would have been obvious to one of ordinary skill in the art at the time the invention was made to expose the semiconductor wafer to a cleaning solution comprising tetramethylammonium hydroxide and at least one surfactant . . . in view of the suggestion in Skee that a cleaning solution comprising tetramethylammonium hydroxide (TMAH) and at least one surfactant . . . is more effective in removing contaminants." (See, Office Action at page 4.) However, nothing in the cited references or in the knowledge of a person of ordinary skill in the art suggests the desirability of, or provides an objective reason for, using the compounds recited in independent claims 1 and 19. As acknowledged by the Examiner, the cited references do not teach or suggest using the compounds recited in amended independent claims 1 and 19. (See, *Id.* at page 6.) However, the Examiner states that it would be obvious to use the recited compounds because "the change from one non-ionic surfactant to the other non-ionic surfactant would have been obvious because: 1) it appears that it is within the skill of one in the art at the time the invention was made to change from one non-ionic surfactant to the other non-ionic surfactant, or 2) both of the non-ionic surfactants are effective at contributing to removing organic residues." (See, *Id.*) However, these reasons by the Examiner are conclusory because they are not supported by objective evidence of record. While Skee describes using two nonionic surfactants, as shown in Table 14 of Skee, changing the surfactant or altering the concentration of the surfactant can create large fluctuations in the effectiveness of the cleaning solution. (Skee at column 27, lines 30 through 44.) Thus, contrary to the Examiner's assertions, there is little or no predictability for interchanging surfactants in cleaning solutions, such as those of Wu or Skee.

Claims 2-10, 12-18, and 20-26 are allowable, *inter alia*, as depending from an allowable base claim.

Dependent claim 12 is further allowable because the cited references do not teach or suggest exposing the semiconductor wafer to a cleaning solution that comprises "from approximately 20% to approximately 50% α-(nonylphenyl)-omega-hydroxy-branched poly (oxy-1,2-ethanediyl) and from approximately 2% to approximately 10% 2,4,7,9-tetramethyl-5-decyne-4,7-diol-ethoxylate." Since neither of the cited references teaches or suggests these compounds, the cited references necessarily do not teach or suggest percentages at which the compounds are used.

Dependent claims 14 and 15 are further allowable because the cited references do not teach or suggest exposing the semiconductor wafer to a vibrational energy ranging from approximately 40 kHz to approximately 104 kHz or from approximately 850 kHz to approximately 1.5 MHz. The cited references do not teach or suggest a frequency of vibrational energy. While Wu et al. teaches using "an ultrasonic (or megasonic) power of about 10-2000 watt," Wu et al. does not disclose the frequency at which the vibrational energy is generated. (Wu et al. at column 2, lines 44 and 45.) Skee does not teach or suggest the use of either megasonic or ultrasonic vibrational energy and, therefore, does not cure the deficiencies in Wu.

Dependent claim 25 is further allowable because the cited references do not teach or suggest "contacting the semiconductor wafer with a high-pressure jet spray or a high-velocity aerosol spray," as acknowledged by the Examiner. (See, Office Action at page 7.)

Since the cited references do not teach or suggest all of the claim limitations and do not provide a motivation to combine, the obviousness rejection of claims 1-10 and 12-26 is improper and should be withdrawn.

New claim 30 is allowable because the cited references do not teach or suggest "exposing the semiconductor wafer to a cleaning solution that consists essentially of tetramethylammonium hydroxide and at least one surfactant, the at least one surfactant comprising at least one acetylenic diol surfactant." Since the cleaning solution of Wu includes ammonium hydroxide, hydrogen peroxide, and water, this cleaning solution does not consist essentially of tetramethylammonium hydroxide and at least one surfactant, as recited in claim 30. Since the cleaning solution of Skee includes a chelator, a silicate, TMAH, and a surfactant, this cleaning solution also does not consist essentially of tetramethylammonium hydroxide and at least one surfactant, as recited in claim 30.

Obviousness Rejection Based on U.S. Patent Application Publication No. 2004/0132384 to Chen in View of Skee and Further in View of Wu et al. and Knowledge in the Art

Claims 1 through 26 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent Application Publication No. 2004/0132384 to Chen ("Chen") in view of Skee and further in view of Wu et al. and knowledge in the art. Claim 11 has been canceled, rendering moot the rejection as to this claim. Applicants respectfully traverse the rejection as to the remaining claims, as hereinafter set forth.

The obviousness rejection of claims 1 through 10 and 12 through 26 is improper because the cited references do not teach or suggest all of the claim limitations. Furthermore, the cited references do not provide a motivation to combine their teachings to produce the claimed invention.

Chen teaches a method of cleaning a semiconductor wafer using a strong acid or oxygen plasma to remove organic residue from alignment marks. (Chen, at paragraphs [0007] and [0023].) The strong acids include hydrochloric acid, sulfuric acid, or nitric acid. (*Id.* at paragraph [0008].) Specifically, Chen teaches using concentrated strong acids, such as 18M sulfuric acid. (*Id.* at [0020].) Although Chen mentions use of "ammonium hydrogen peroxide" ("AMP") type cleaning solutions, Chen describes at length many pitfalls and drawbacks of using such solutions. (*Id.* at paragraphs [0005] and [0023].) Chen does not teach using vibrational energy, a specified pH range for the cleaning solution, a temperature at which the solution should be applied, or a method of application (immersion or spray or high-velocity spray, etc.). In addition, the Examiner admits that "Chen fails to disclose a width for the trench of the registration mark as claimed, fails to disclose that the cleaning solution comprises tetramethylammonium hydroxide and at least one surfactant of acetylenic diol, and fails to disclose exposing the semiconductor wafer to ultrasonic or megasonic vibrational energy as claimed." (See, Office Action at page 8.)

The teachings of Skee and Wu are as previously summarized.

The cited references do not teach or suggest the limitations of "exposing the semiconductor wafer to a cleaning solution comprising tetramethylammonium hydroxide and at least one surfactant, the at least one surfactant comprising α-(nonylphenyl)-omega-hydroxy-branched poly (oxy-1,2-ethanediyl) and 2,4,7,9-tetramethyl-5-decyne-4,7-diol-ethoxylateα-(nonylphenyl)-omega-hydroxy-branched poly (oxy-1,2-ethanediyl) and 2,4,7,9-tetramethyl-5-decyne-4,7-diol-ethoxylate" or "contacting the semiconductor wafer with a spray of a cleaning solution comprising tetramethylammonium hydroxide and at least one surfactant, the at least one surfactant comprising α-(nonylphenyl)-omega-hydroxy-branched poly (oxy-1,2-ethanediyl) and 2,4,7,9-tetramethyl-5-decyne-4,7-diol-ethoxylate" as recited in independent claims 1 and 19, respectively. As previously discussed, Wu and Skee do not teach or suggest these limitations of the claims. As acknowledged by the Examiner, Chen also does not teach or suggest these limitations and, therefore, does not cure the deficiencies in Wu and Skee. (See, Office Action at page 11.) The knowledge in the art also does not teach or suggest these limitations.

The cited references also do not provide a motivation to combine to produce the claimed invention. The Examiner state that "it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a solution comprising tetramethylammonium hydroxide and at least one surfactant of acetylenic diol instead of the solution disclosed by Chen for removing organic residues . . . in view of the suggestion in Skee that a cleaning solution comprising tetramethylammonium hydroxide (TMAH) and at least one surfactant . . . is effective in removing organic contaminants." (See, *Id.* at page 9.) However, this reasoning by the Examiner is conclusory because the cited references do not provide any motivation to replace the cleaning solution of Skee with a solution having a strong acid or oxygen plasma. Rather, these two cleaning solutions rely on completely different chemistries to clean the semiconductor wafers.

In addition, the cited references teach away from such a combination. One of ordinary skill in the art, upon reading Chen, would not be motivated to combine Chen with Skee because Chen teaches away from using AMP cleaning solutions. Chen clearly states that an "ammonium hydrogen peroxide mixture (AMP) . . . cannot effectively remove organic residue," and that AMP "produces adverse effects, such as reaction with metal, thereby damaging wafers. Overall production yields are thus seriously affected." (Chen at paragraph [0005].) In other words, the

cleaning solution of Chen is suggested as an allegedly superior alternative to the AMP cleaning solutions because "[c]onventional damage occurring to wafers when using HF or AMP to clean wafers is avoided." (*Id.* at paragraph [0023].) Since Chen teaches away from using AMP solutions, such as the cleaning solution disclosed in Skee, one of ordinary skill in the art would not be motivated to combine Chen with Skee because Chen states that these methods damage wafers and are inferior.

Claims 2-10, 12-18, and 20-26 are allowable, *inter alia*, as depending from an allowable base claim.

Claims 12, 14, 15, and 25 are further allowable over the cited references for the reasons previously discussed. Chen does not cure the previously discussed deficiencies in Wu and Skee. Specifically, Chen does not teach or suggest exposing the semiconductor wafer to a cleaning solution that comprises "from approximately 20% to approximately 50% α-(nonylphenyl)-omega-hydroxy-branched poly (oxy-1,2-ethanediyl) and from approximately 2% to approximately 10% 2,4,7,9-tetramethyl-5-decyne-4,7-diol-ethoxylate," as recited in claim 12.

Chen also does not teach or suggest exposing the semiconductor wafer to a vibrational energy ranging from approximately 40 kHz to approximately 104 kHz or from approximately 850 kHz to approximately 1.5 MHz, as recited in claims 14 and 15, because Chen does not teach exposing the semiconductor wafer to ultrasonic or megasonic vibrational energy. The Examiner acknowledges that Chen does not teach or suggest this limitation. (See, Office Action at page 8.)

Chen also does not teach or suggest "contacting the semiconductor wafer with a high-pressure jet spray or a high-velocity aerosol spray," as recited in claim 25, as acknowledged by the Examiner. (See, *Id.* at page 12.)

Since the cited references do not teach or suggest all of the claim limitations and do not provide a motivation to combine, the obviousness rejection of claims 1-10 and 12-26 is improper and should be withdrawn.

New claim 30 is also allowable because the cited references do not teach or suggest "exposing the semiconductor wafer to a cleaning solution that consists essentially of tetramethylammonium hydroxide and at least one surfactant, the at least one surfactant comprising at least one acetylenic diol surfactant." Since the cleaning solution of Chen includes a strong acid or oxygen plasma, Chen does not teach or suggest a cleaning solution that consists

essentially of tetramethylammonium hydroxide and at least one acetylenic diol surfactant. In addition, as previously discussed, Wu and Skee do not teach or suggest this limitation because their respective cleaning solutions do not consist essentially of tetramethylammonium hydroxide and at least one acetylenic diol surfactant.

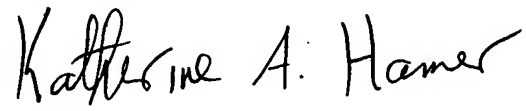
## ENTRY OF AMENDMENTS

The amendments to claims 1, 3, and 19 above should be entered by the Examiner because the amendments are supported by the as-filed specification and drawings and do not add new matter to the application.

## CONCLUSION

Claims 1-10, 12-26, and 30 are believed to be in condition for allowance, and an early notice thereof is respectfully solicited. Should the Examiner determine that additional issues remain which might be resolved by a telephone conference, he is respectfully invited to contact Applicants' undersigned attorney.

Respectfully submitted,



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Attachment: Corrected Declaration (3 pages)
Date: November 30, 2004
KAH/ps:ljb
Document in ProLaw